TECTONIC DOMAINS IN THE EASTERN HEMISPHERE OF MARS

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The definition of boundaries of discrete structural provinces on the surface of Mars has previously been made by the assumptions of circular or radial symmetry (in the case of the Tharsis plateau), by artificial quadrangle boundaries for regional studies, or simply by regional geographical features. Much of the planetary structural mapping has been presented in a line or spot format in existing consortium data. We are presently generating methods to convert the detailed maps of tectonic features to a format that can be used with standard image processing techniques. In this manner such data can be more readily compared to age and other attributes deduced from geologic mapping, gravity results, and topography. The 24 photomosaics covering the eastern hemisphere of Mars have already been examined for four types of structural features: erosional remnants, ridges, graben, and scarps. When digitized, each feature was flagged according to feature type, azimuth and length. These values were stored as text files on a quad-by-quad basis for each quad studied.

To exploit the speed and flexibility of image processing techniques and to remove artifical limits imposed by quadrangle boundaries, we have now reorganized the data by feature type rather than by quad, and converted the data from text to image format. For instance, ridge data for each quad were combined into one dataset,and were then grouped according to 1/4° bins to be compatible with the Mars Consortium format. The number of data points in the bin, the vector mean azimuth and the vector mean length were calculated for each 1/4° bins. When coded as gray tones according to their magnitude and written as image files, these calculated values provided three channels of image data for each type of structural feature. Now in a form analogous to the BGR triplet of conventional imaging data, the tectonic data can be manipulated and compared with other available data.

The development of this method for treating structural features was prompted by the need to sort these data by topography and geologic map unit in the eastern hemisphere. Our initial studies of this re-formatted data looked for the distribution of azimuths for each feature and the relationships to topography, geology and age. Graben (n=807) revealed a strong azimuthal trend of 0°-40° and 120°-130°, but only at lower elevations north of the CTB. Similarly, erosional remnants (n=522) showed less-defined azimuthal concentrations, but also occurred only at low elevations. These directional and topographic preferences became clear only in combination with additional geological data.

One ultimate goal of using this technique is the ability to use the vast array of image processing statistics on encoded versions of the tectonic features. For example, a principal components analysis on two

images of ridge and graben azimuths would immediately indicate the degree of correlation between the two features, and displaying the first principal component image would provide a view of the geographic region with the highest degree of correlation. However, in our initial attempts at such analyses, we ran into the problem of aliasing in that each 1/4° geographic bin may not contain features (especially in 1/4° format), and the statistics were highly skewed towards 0-values.

To address this problem, the data were re-sampled into 1° bins, so that the coarser resolution would show longer wavelength trends, and would also facilitate statistical comparison of tectonic features by increasing the fraction of the image array actually containing data. The large geographical extent of the data set should help to separate Tharsis tectonic controls from more localized controls of eastern hemisphere tectonic regimes. Preliminary results indicate that the orientation of compressional features is particularly sensitive to topography in the eastern hemisphere, where trends north of the boundary at low elevations are consistent with Tharsis-related compressional stress, whereas those at high elevations suggest a NW-SE global-scale fabric. In contrast, the orientations of grabens are not related to topographic setting; NW trends to dominate in both the ancient cratered terrain and in the smooth plains, and are probably due to later periods of extension as well as retreat of the CTB scarp. Both geographic setting and orientation of graben correlate more closely with the orientation of graben than with other features. Consequently we believe that this technique is well suited to regional tectonic problems on Mars, and will aid in distinguishing domains not geographically constrained by artificial boundaries.